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Title 1: How Life Begins.

Title 2: The Story of how new plants and animals come into existence.

Title 3: Produced and photographed by George E. Stone, A. B., in collaboration with J. A. Long, Ph. D., Assistant Professor of Embryology, University of California.

Title 4: Life comes only from life. All new individuals arise only from other living creatures of their own kind.

Title 5: There are several methods by which new individuals arise. The simplest method is found in those animals and plants which consist of one cell.

Title 6: Let us take some of these tiny animals. They are called Protozoans. They live in stagnant water and can be seen only with a microscope.

Scene 1. Man with microscope and jar of water.

Scene 2. "Close up" of hand. Drop is taken.

Scene 3. "Cut back" to scene one. Man looks into microscope.

Scene 4. Protozoans under low power.

Title 7: Increasing the magnification.

Scene 5. "Close up"; man changes objective.

Scene 6. Protozoans highly magnified.

Scene 7. Binary fission begins.

Scene 8. (1) Diagram of Protozoa.

(2) Three protozoans: each consisting of a single cell - full grown but not yet ready to divide.

(3) This protozoan is dividing into two cells - each of which will be a new protozoan.

Scene 9. Scene 8 continued.

Title 8: We shall now look at a microscopic plant - yeast - used in making bread.

Scene 10. Man at microscope.

Scene 11. Close up - scrapes yeast cake.

Scene 12. "Cut back" to scene 10.

Scene 13. Diagram of yeast cells.

- (1) Each of these cells is a separate yeast plant.
- (2) Watch closely and see how each plant cell buds off another like itself.
- (3) By this process new yeast cells come into existence.

Scene 14. Growing yeast cells.

Title 9: We have now seen how simple animals and plants produce others like themselves merely by dividing or by budding. These are the simplest methods by which new life can arise.

Title 10: Larger and more familiar plants produce others like themselves either from cuttings or seeds.

Title 11: I us take a cutting from a geranium, plant it, and it grow.

Scene 15. Garden with gardener.

Scene 16. Close up. Stoops over.

Scene 17. Close up of bush alone.

Scene 18. Cut back to scene 16.

Scene 19. He plants the cutting.

Title 12: Usually a plant comes from a seed. The seed originates in a flower on the parent plant.

Title 13: We shall now study the pea blossom to see how seeds originate.

Title 14: A pea blossom.

Scene 20. A pea blossom.

Title 15: The flower consists of several parts.

Scene 21. Diagram: Pea blossom cut open. Labeled

- (1) Petal
- (2) Sepal
- (3) Stamen
- (4) Pistil

Title 16: The pistil and stamens are the only parts which are directly concerned in the formation of the seed.

Scene 22. Diagram, Pea Blossom cut open. Labeled

(1) Stamen

(2) Pistil

Title 17: The pistil.

Scene 23. Diagram of Pistil. Labeled

(1) Petal

(2) Stamen

(3) Pistil

(4) Sepal

Scene 24. All removed but pistil, which rotates. Labeled

(1) Pea Blossom cut open

(2) Pistil

Scene 25. Diagram of Pistil, enlarged. Labeled

(1) Stigma

(2) Style

(3) Ovary

(4) An ovule

(5) Each ovule becomes a seed (or pea)

Title 18: Photograph of Pistil.

Scene 26. Photograph of Pistil.

Title 19: The Stamen.

Scene 27. Diagram, Pea Blossom cut open, labeled petal, stamen, pistil, sepal. All is removed but stamen - labeled anther, filament.

Title 20: Photograph of Stamen.

Scene 28. Photograph of three stamens.

Title 21: In the anther are found pollen grains which burst forth.

Scene 29. Anther on filament.

Title 22: Pollen grains highly magnified.

Scene 30. Pollen grains magnified.

Title 23: How ovules become seeds.

Scene 31. Diagram of Pistil. Labeled

- (1) An ovule.
- (2) Each ovule becomes a seed.
- (3) But before each ovule can become a seed, pollen grains must fall on the stigma.
- (4) Pollen grains on the stigma grow and form tubes.

24: Pollen grains will also grow in a solution of sugar and form tubes like those which they form in the pistil.

Scene 32. The pollen grains growing.

Scene 33. Diagram: The pollen grains growing. Labeled

- (1) Pollen grains, ovule.
- (2) Pollen tube.
- (3) The pollen tube enters an ovule.
- (4) A pollen tube enters each ovule.
- (5) This ovule will now be seen enlarged.

Scene 34. Diagram: The Ovule Enlarged. Labeled

- (1) Surface view, ovule (knife cuts ovule in two).
- (2) Ovule cut through the middle.
- (3) Embryo sac.
- (4) Nucleus of Embryo sac - later is removed and the nucleus is seen to divide and gives rise to -
- (5) Egg cell (female).
- (6) Male cell (enters with pollen tube).
- (7) Union of egg cell with male cell.
- (8) This union is called fertilization.

Title 25: After fertilization, the ovules develop into peas and the rest of the pistil becomes a pod.

Scene 35. Series from pistil to pod illustrates change.

Title 26: Meanwhile, within each pea, the fertilized egg cell becomes an embryo plant.

Title 27: Pea cut open to show embryo.

Scene 36. Pea cut open to show embryo.

Scene 37. Diagram of Embryo Plant. Labeled

(1) Embryo plant.

(2) Plumule-embryo leaves.

(3) Radicle - embryo root.

(4) Cotyledon - food of plant.

Scene 38. When a pea is planted in the ground, kept moist, and by the sun, the embryo plant grows.

Scene 38. Close up - hand with trowel makes trench.

Scene 39. Growing plant.

Title 29: We have seen how a plant and its flowers develop from a seed, also how this seed results from the union of an egg cell and a male cell. The egg cell came from an ovule and the male cell came from a pollen grain.

Title 30: Just as peas originate in the flower, so do all kinds of fruits and seeds begin as parts of a flower.

Title 31: An apple orchard in bloom.

Scene 40. Apple orchard in bloom.

Title 32: Apple blossoms opening.

Scene 41. Apple blossoms opening.

Title 33: Bees, in gathering nectar from flowers, help to scatter pollen on the stigmas.

Title 34: Bees on apple blossoms.

Scene 42. Bees on apple blossoms - distant view.

Scene 43. Bees on apple blossoms - distant view.

Scene 44. Bees on apple blossoms - close up.

Scene 45. Bee on single blossom - extreme close up.

REEL II.

Title 35: The Development of Higher Animals.

Title 36: The higher animals which we shall study are the sea urchin, a butterfly, the frog, and a mammal.

Title 37: In all of these, as in the pea, the young animals develop from fertilized eggs.

Title 38: The Sea-Urchin.

Title 39: The Sea Shore at low-tide. Where the Sea-Urchins live.

Scene 46. Woman on rocks gathering sea-urchins.

Scene 47. "Close up" of gathering.

Title 40: Some of these sea-urchins are females and produce eggs within their bodies; the others are males and proclude spermatozoa. The eggs and spermatozoa escape through tiny openings into the sea water.

Scene 48. Sea-urchins in pools.

Scene 49. "Cut back" to scene 47.

Scene 50. "Close up" of arm.

Title 41: Eggs and Spermatozoa in sea water.

Scene 51. Eggs and sperm in sea water.

Scene 52. Diagram. Labeled

(1) Eggs.

(2) The tiny dancing dots are spermatozoa.

Scene 53. "Cut back" to scene 51.

Scene 54. ^{moving} Diagram of Fertilization of Egg of Sea-Urchin. Labeled

(1) Spermatozoon (from male).
Egg (from female).

(2) This union of egg and spermatozoon is called fertilization.

Title 42: After fertilization, the egg divides into two cells.

Scene 55. Diagram of two cells.

Scene 56. Photograph of two cells.

Title 43: The second division produces four cells.

Scene 57. Diagram of four cells.

Scene 58. Photograph of four cells.

Title 44: After a third division there are eight cells.

Scene 59. Diagram of eight cells.

Scene 60. Photograph of eight cells.

Title 45: Further divisions result in swimming embryos.

Scene 61. Swimming embryos.

Title 46: The embryos become transformed into young sea-urchins.

Title 47: Papilio - The Swallow-tail butterfly.

Title 48: The female lays her eggs - already fertilized, upon the leaves of the sweet anise.

Scene 62. Butterfly on anise.

Title 49: When first laid the egg is creamy white.

Scene 63. Egg on anise.

Title 50: Ten days later the dark form of the embryo can be seen through the membrane of the egg.

Scene 64. Dark egg on anise.

Title 51: Soon the embryo eats its way out and hatches as ^a tiny black caterpillar.

Scene 65: Caterpillar and egg.

Title 52: His first meal consists of the empty egg shell. After that, he feeds entirely on the delicate leaves of the anise.

Scene 66. Caterpillar on egg.

Scene 67. Caterpillar on anise.

Title 53: During the first ten days after hatching, the caterpillar sheds its skin three times. At the third "molt" he loses his black, hairy skin and emerges a beautiful green caterpillar marked with yellow and black.

Scene 68. Shedding of Skin.

Title 54. For another ten days the caterpillars are quite active,

Scene 69. Caterpillars on anise.

Title 55: --and eat ravenously.

Scene 70. Caterpillar eating.

Title 56: Now the larva undergoes a profound change by which it becomes transformed into a butterfly.

57: First the caterpillar spins a silken loop by which it attaches itself to a firm support.

Scene 71. Caterpillar attached to stalk.

58: Within a day or two its skin splits down the back and it wriggles ^{out} ~~into~~ a chrysalis.

Scene 72. Skin splits and chrysalis emerges.

59: The chrysalis may last several months during which it hangs motionless.

Scene 73: Chrysalis attached to stalk.

60: At length the chrysalis shows signs of activity and at ^{down} end of about two days, suddenly splits ~~from the front~~ struggles a butterfly with crumpled wings.

Scene 74. The emergence of the butterfly from the cocoon.

Title 61: The newly emerged butterfly clings to the stalk while its wings expand.

Scene 75. The butterfly's wings expand.

Title 62: Three hours later: the wings are now fully extended and the beautiful creature takes flight.

Scene 76. Butterfly with wings fully extended.

Scene 77. Butterfly seen flying away.

Title 63: Among the flowers.

Scene 78. Butterfly is seen on a rose from beneath.

Scene 79. Butterfly is shown on a gladiola.

Title 64: The development of the frog.

Title 65: In the spring the frogs come out of their hiding places. The body of the female is distended with eggs.

Scene 80. Female frog on marsh grass.

Scene 81. Another view of same.

Title 66: The frogs seek quiet ponds.

Scene 82. Panoram^a of frog-pond.

Title 67: When the female lays her eggs in the water they are fertilized - as in the sea-urchin - by spermatozoa from the male.

Scene 83. Boy gathering eggs.

Scene 84. "Close up" of jar full of frog eggs.

Title 68: Fertilized eggs are surrounded and held together in clusters by thick layers of protective jelly.

Scene 85. Eggs magnified in clusters.

Scene 86. Single egg highly magnified.

Title 69: Soon after fertilization each egg begins to divide much as in the sea-urchin. How this division proceeds may be seen in the following diagram.

Scene 87. Movable diagram showing division of egg.

graph of dividing egg.

Scene 88. Dividing egg.

Title 71: Four hours later.

Scene 89. Same eggs are shown with much smaller cells.

Title 72: Two days old; a groove appears on upper side of the egg.

Scene 90. Photograph of egg with groove.

Title 73: This becomes the brain and spinal cord.

Scene 91. Photograph of frog embryo showing spinal cord.

Title 74: Two embryos - less highly magnified. They are being moved about with glass rods in order to show all sides.

Scene 92. Two embryos.

Title 75: Third day - the embryo is rapidly assuming the shape of a tadpole.

Scene 93. Two embryos.

Title 76: Fourth day - the tail grows rapidly.

Scene 94. Two embryos.

Scene 95. Diagram of embryo of frog labeled, Back view - head, neck, and tail.
Side view - tail and head.

Scene 96. "Cut back" to scene 94.

Title 77: Sixth day: beginning of muscular activity.

Scene 97. Two tadpoles' activity.

78: Great activity in the egg cluster. The tadpoles wiggle out of the jelly and are hatched.

Scene 98. Tadpoles wiggling in jelly mass.

79: Soon after hatching external gills develop on the sides just back of the head - by these the tadpole breathes.

Scene 99. Two tadpoles.

80: Tadpole highly magnified to show gills.

Scene 100. Diagram of embryo of frog, labeled head, gill, body, muscles.

Scene 101. Photograph of tadpole showing gills.

Title 81: The eggs have now been transformed into tadpoles.

Scene 102. Stirring frog's eggs and embryos.

Scene 103. "Close up" of same.

Title 82: The bottom of the frog pond. For about three months this is the tadpole's home.

Scene 104. Bottom of the frog pond.

Title 83: Fifth week - By this time the tadpoles have grown much larger and tiny hind legs without joints have appeared.

Scene 105. Single tadpole with jointless legs.

Title 84: Second month - the legs become jointed.

Scene 106. Tadpole with jointed legs.

Title 85: End of third month - front legs make their appearance.

Scene 107. Underwater: Tadpole with four legs.

Title 86: Lungs begin to take the place of gills and except for the tail the appearance is quite froglike.

Scene 108. Well developed tadpole with full-grown legs.

Title 87: The tail is slowly absorbed and the animal breathes by means of lungs.

Scene 109. Tadpole with short tail.

Title 88: Frog at last - the tail is entirely gone, the skin has acquired its color and pattern, and the frog is ready to leave the water.

Scene 110. Frog with no tail.

Scene 111. Frog on rock beside pool.

Scene 112. Frog jumps away.

Title 89: In the animals thus far studied the young receive no care from the parents. In the examples to follow it will be observed that the mother cares for her offspring from the time that the egg begins to develop until the young can care for themselves.

REEL III.

Title 90: The development of the chick.

Scene 113. Woman puts eggs in nest.

Scene 114. "Close up" putting eggs in nest.

Scene 115. "Cut back" to 113.

Title 91: The eggs cannot develop unless they are kept warm.

Title 92: The warmth is provided by the body of the mother hen, who sits on them until they are hatched.

Scene 116. "Close up" - hen comes up to nest. --

Scene 117. Distant view of hen at nest.

Scene 118. "Close up" - hen gets on the nest.

Scene 119. Distant - hen and nest are placed under coop.

Title 93: We are now to examine the egg in order to see how it gives rise to a chick.

Scene 120. Diagram of hen's egg -- side view, labeled

(1) Shell.

(2) Shell membrane.

- (3) Air chamber.
- (4) The "yolk" only is the true egg. It corresponds to the eggs of the sea-urchin, butterfly, and frog.
- (5) "Vitaline", or egg membrane.
- (6) Albumen.
- (7) Twisted albumen.
- (8) The albumen or "white" is food for the chick embryo.
- (9) The embryo forms here. This part is always uppermost.

e 94: Before the egg can develop into a chick, a spermatozoon must unite with a part of the yolk. This fertilization takes place within the body of the hen, before the yolk is surrounded by the white and the shell.

top of the shell is carefully removed, the embryo may be seen lying on the top of the yolk. The embryo shown is ~~about~~ thirty-six hours old.

Scene 121. "Close up" of hands and instruments cutting open egg.

Scene 122. Chick embryo.

Scene 123. Diagram. Labeled

- (1) Brain.
- (2) Beginning of eye.
- (3) "heart" (beating)
- (4) Beginning of blood vessels.

Scene 124. "Cut back" to 122.

Title 96: Fifty-two hours old.

Scene 125. Chick embryo.

Scene 126. Diagram. Labeled brain, eye, "heart" (beating), blood vessels, notice blood circulating, tail.

Scene 127. "Cut back" to 125.

Title 97: Seventy-two hours old.

Scene 128. Chick embryo.

Title 98: One hundred hours old: A network of blood vessels has extended further over the yolk and carries nourishment to the embryo.

Scene 129. Breaking open egg.

Scene 130. Embryo enlarged.

Title 99: Nine days old.

Scene 131. Embryo.

Title 100: Twenty-one days old: The hatching of the egg.

Scene 132. Egg is seen hatching.

Title 101: Beneath the hen the other eggs have also hatched.

Scene 133. Distant view of coop with hen on nest. Hen and nest is carried out.

Scene 134. "Close up"; hen removed from nest to show chicks.

Scene 135. "Close up"; chicks and hen.

Scene 136. Hen with chicks on back.

Title 102: The mammals.

Title 103: The mammals are warm-blooded animals which have hair. The young begin their existence as eggs which are fertilized within the body of the mother.

Title 104: There they are kept warm and nourished and there they develop until they are born. After birth they are supplied with milk produced by the mother.

Title 105: As examples of mammals may be mentioned the rat, the cat, the horse, and the human being.

Title 106: The development of a typical mammal - the rat.

Title 107: The parent rats.

Scene 137. The parent rats.

Title 108: The eggs are microscopic.

Scene 138. Photograph of ^{living} rat's eggs.

Scene 139. Diagram of egg of rat labeled.

Title 109: Egg surrounded by follicle cells.

Scene 140. "Cut back" to 138.

Title 110: Eggs and spermatozoa.

Scene 141. Egg and spermatozoa.

Scene 142. Diagram. Labeled

(1) Egg separating from follicle cells.

(2) Spermatozoa.

Scene 143. "Cut back" to 141.

Title 111: Fertilization is brought about by one spermatozoon which enters the egg.

Scene 144. Egg and spermatozoa.

Scene 145. Diagram labeled

(1) Eggs separated from follicle cells.

(2) Spermatozoa.

Scene 146. "Cut back" to 144.

Title 112: More highly magnified.

Scene 147. Eggs and sperm more highly magnified.

Title 113: Ten days after fertilization the egg has become an embryo.

Scene 148. Small embryo of rat.

Title 114: Twelve days.

Scene 149. 12-day embryo.

Title 115: Thirteen days.

Scene 150. 13-day embryo.

Title 116: Fourteen days.

Scene 151. 14-day embryo.

Title 117: Fifteen days.

Scene 152. 15-day embryo.

Title 118: Sixteen days.

Scene 153. 16-day embryo.

Title 119: Seventeen days after fertilization, or five days before birth.

Scene 154. 17-day embryo.

Title 120: The new-born rats are quite helpless.

Scene 155. Man takes mother from nest and shows new-born rats.

Title 121: Eleven days old: they still need their mother's care.

Scene 156. Mother rat carries young ones into nest.

Title 122: Twenty days old. Old enough to wash themselves.

Scene 157. Scene of young ones washing their faces.

Title 123: e examples of flowering plants and higher animals, which we have now seen, show in each case how life begins in a fertilized egg cell.

the development of such eggs within the mother cat
kittens come into existence.

Scene 158. Mother cat and kittens.

Scene 159. Kittens in basket (close up).

Scene 160. Still closer. Kittens in basket.

Title 125: The same is true of the horse.

Scene 161. Photograph of mare and her foal.

Title 126: And it is by the same processes of growth and development that the human being comes into life.

Scene 162. Human child.

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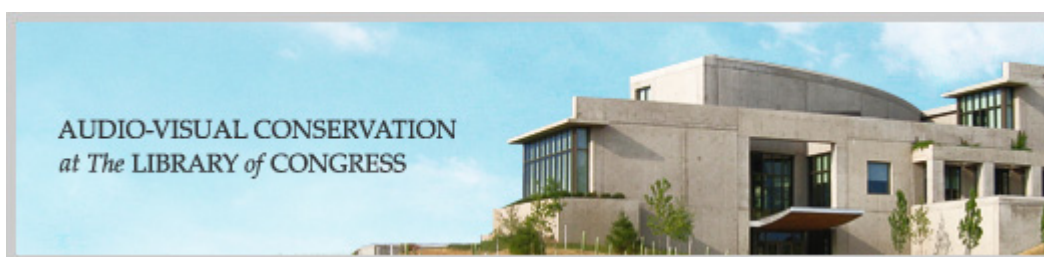
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